DRAFT
Concept Paper of Proposed Early Action for Residential Refrigeration Measure

I. Overview

This measure involves establishing a voluntary program to upgrade pre-2002, less energy efficient residential refrigerators and freezers as the older units reach their end-of-life (EOL) and to ensure proper recovery of refrigerants and foam blowing agents that have high global warming potential (high-GWP). At the program start the vast majority of appliances recycled will be inefficient, pre-1996 refrigerators using greenhouse gas (GHG) refrigerants and foam blowing agents totaling about 9,900 metric tons carbon dioxide equivalent ($MTCO_2E$) per appliance followed by a transition to pre-2002 refrigerators using refrigerants and foam blowing agents that translate into about 1,350 $MTCO_2E$ per appliance.

The measure is expected to include developing strategies to support appliance take-back/upgrade and early retirement programs (generally referred to as early retirement programs throughout document) such as the U.S. Environmental Protection Agency (US EPA) Responsible Appliance Disposal (RAD) program[1] and EnergyStar program, in addition to programs administered by local utilities to address domestic appliances energy efficiency, which also result in direct and indirect GHG emission reductions.

This measure will be coordinated with the Foam Recovery/Destruction measure, another early action measure that is expected to require EOL recovery of high-GWP refrigerants and foam blowing agents from appliances. The Residential Refrigeration program will focus on operating refrigerators, while the Foam Recovery/Destruction measure will focus on non-operating refrigerators.

This measure will focus on increasing the number of refrigerators entering the waste stream that will be properly recycled to reduce GHG emissions. If all waste refrigerant, foam, and other materials are properly recycled,[2] direct GHG emissions avoidance benefits may be significant, which will also lead to reductions in indirect GHG emissions due to the use of more efficient units. Based on California law all appliances are required to be recycled and the refrigerant recovered, but there is no requirement to recover foam blowing agents. A primary benefit of this measure would be to ensure recycling of appliances including the recovery and destruction of foam blowing agents.

II. Background

Need for Regulations:

Specific to residential refrigeration there is not an anticipated need for regulations.

The California Global Warming Solutions Act of 2006 (AB 32) requires the Air Resources Board (ARB) to adopt a statewide GHG limit equivalent to the statewide GHG levels in 1990 to be achieved by 2020. ARB staff identified residential

[1] A foam recovery program for appliances is currently operating as an incentive program between US EPA and utility companies, some of which are located in California (Responsible Appliance Disposal program, or RAD, http://www.epa.gov/ozone/snap/emissions/radp.html). The program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

[2] Proper recycling of an appliance for the purpose of this measure means all materials are recycled and all high-GWP GHGs from refrigerants and foams are destroyed.

refrigeration as a source of emissions of high-GWP GHGs that include chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), and hydrofluorocarbons (HFC).

In AB 32 the definition of GHGs includes carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. As these same gases are listed in the Kyoto Protocol they are commonly referred to as Kyoto gases. Although CFC and HCFC are ozone depleting substances (ODS) that are not listed as GHGs under the Kyoto Protocol (referred to as non-Kyoto gases) nor explicitly listed in AB 32, they represent a significant volume of banked high-GWP GHGs that are a potential source of continued emissions for several more decades, due to the long lifespan of appliances.

The US EPA estimates that nearly 10 million refrigerators and freezers are disposed of in the U.S. each year.[3] By multiplying the 10 million refrigerators and freezers by the percentage of the U.S. population residing in California (12.13%) the total annual disposal in California is estimated at 1.2 million refrigerators and freezers.

Pre-1996 appliances contain CFC refrigerants and foam blowing agents, pre-2002 appliances contain HFC refrigerants and HCFC foam blowing agents, and post-2002 appliances contain HFC refrigerants and foam blowing agents. CFC and HCFC are ODS; CFC, HCFC, and HFC are all high-GWP GHGs.

Federal and State laws and regulations require the recovery of all refrigerants for destruction or reclamation, but there are no laws or regulations governing the management of foam blowing agents at an appliance EOL.

If high-GWP GHGs are not recovered from foams at EOL, they will be released in large part to the atmosphere during shredding and landfilling. Recovery of insulating foams from appliances has been demonstrated to be technologically and economically feasible in California through current appliance early retirement programs managed by utility companies, with collected appliances processed by Appliance Recycling Centers of America, Inc. (ARCA) and JACO Environmental, Inc.[4]

Overview of Sector (Current Control Practices):

The Montreal Protocol focused on the decision to phase out the production and consumption of ODS in products worldwide. In the United States this was accomplished with the passage of the Clean Air Act (CAA). The US EPA issued a rule in July, 1992 requiring the gradual reduction in the production of CFC and for producers to phase them out completely by January 1, 2000.[5] In order to meet the HCFC production and consumption limits set under the Montreal Protocol, the US EPA issued

[3] US EPA, Appliance Disposal Practices in the United States, http://www.epa.gov/Ozone/partnerships/rad/raddisposal_factsheet.html, retrieved February 27, 2008.
[4] Southern California Edison Safeguarding the Environment One Appliance at a Time, http://www.epa.gov/ozone/partnerships/rad/downloads/RAD_SCE_Case_Study.pdf, retrieved February 28, 2008.
[5] The Accelerated Phaseout of Class I Ozone-Depleting Substances, http://www.epa.gov/ozone/title6/phaseout/accfact.html, retrieved April 18, 2008.

an accelerated phase out of the production and importation of HCFC-141b, HCFC-142b, and HCFC-22.[6] In all developed countries, household refrigerators were redesigned to perform with CFC substitutes by the end of 1996. In the U.S., as in many other countries in the developed world, this redesign was undertaken by assessing the replacements for CFC in terms of product performance, ozone depletion, global warming, toxicity, flammability, economics, and energy efficiency. These undertakings resulted in several different solutions globally.[7]

Fluorocarbons play two roles in home refrigerators - refrigerant and foam insulation blowing agent. The use of refrigerants and blowing agents vary from year to year with the use of CFC, HCFC, HFC, and other CFC substitutes. Table I summarizes the progression that has occurred in the use of the most common, but not only, refrigerants and foam blowing agents for developing countries over three timeframes as the phase out of ODS continues.

Table I – Refrigerant and Foam Blowing Agent Use Progression[8]

Function (Timeframe)	Pre-Montreal Protocol (before 1996)	Transitional (1996-2005)	Non-Ozone Depleting (2003 and beyond)
Refrigerant	CFC-12	HFC-134a Isobutane	HFC-134a Isobutane
Foam Blowing Agent	CFC-11	HCFC-141b Cyclopentane	HFC-134a HFC-245fa HFC-365mfc Cyclopentane Pentane

Appliance management and disposal in California is based on the definition of a "major appliance" defined as any domestic or commercial device, including, but not limited to, a washing machine, clothes dryer, hot water heater, dehumidifier, conventional oven, microwave oven, stove, refrigerator, freezer, air-conditioner, trash compactor, and residential furnace.[9] The context of this paper is specific to appliances that contain high-GWP GHGs, but for simplicity the term appliance will be used throughout.

The California Public Utilities Commission (CPUC) sponsors programs funded with ratepayer dollars to reduce statewide energy consumption. With these funds, a number of California utilities are implementing appliance recycling programs, designed to reduce energy consumption and benefit both consumers and the utility industry. Specifically, these programs encourage retirement of inefficient appliances to reduce energy demand, thereby eliminating the need for utilities to build new power plants, and at the same time, lowering customers' electricity bills.

[6] HCFC Phaseout Schedule, http://www.epa.gov/ozone/title6/phaseout/hcfc.html, retrieved April 18, 2008.
[7] Arthur D. Little, Inc., Global Comparative Analysis of HFC and Alternative Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications, Final Report to the Alliance for Responsible Atmospheric Policy, March 21, 2002, page 4-1.
[8] Ibid.
[9] California Public Resources Code Section 42166.

ODS and HFC foam blowing agents contained in insulating foams found in refrigerators and other appliances are not subject to any regulations; however, a voluntary foam recovery program for appliances is currently operating as an incentive program between US EPA and utility companies, some of which are located in California (Responsible Appliance Disposal program, or RAD, http://www.epa.gov/ozone/snap/emissions/radp.html).

The RAD program helps to enable utilities to get old appliances off the power grid; it is profitable for them to do this, so they are able to provide monetary incentives to facilities such as JACO Environmental and Appliance Recycling Centers of America (ARCA) to properly recycle and recover high-GWP GHGs from refrigerators, as well as to provide cash or credit to people who turn in their old refrigerators and upgrade to EnergyStar appliances. In California, refrigerators received from the utilities are processed to: 1) recover and reclaim or destroy refrigerants and foam blowing agents, 2) recycle metals, plastic, and glass, and 3) recovery and dispose of PCBs, mercury, and used oil.

Current Regulatory Requirements:

Currently, only ODS are regulated under Section 608 of the CAA, which is specific to activities that protect the ozone layer as they apply to stationary refrigeration and air conditioning systems. It should be noted that enforcement of existing rules is weak to non-existent.

Federal Regulations and Programs

Section 608(b) of the CAA requires that ODS contained in bulk in appliances be removed prior to recycling or disposal (40 CFR Part 82 Subpart F).

Section 608 also requires the recovery of all refrigerants for destruction or reclamation (40 CFR Part 82 Subpart F).

Subtitle C of the Resource Conservation & Recovery Act (RCRA) and Subpart D of the Toxic Substances Control Act (TSCA) require proper management and storage of universal waste e.g. mercury, used oil, and PCBs (40 CFR Parts 273, 279, 761).

State Statute, Regulations and Programs

The structure and purpose of state statute and regulations are similar to federal regulations.

Health & Safety Code Section 25212 provides that materials requiring special handling contained in major appliances shall not be disposed of at a solid waste facility and shall be removed from major appliances prior to the appliance being processed in a manner that could release materials that require special handling.

Public Resources Code Section 42175 requires that materials requiring special handling be removed from major appliances prior to crushing for transport or transferring to a baler or shredder for recycling.

Public Resources Code Section 42167 provides definitions of "materials that require special handling" to include: PCBs, CFC, HCFC, other non-CFC replacement refrigerants, used oil in major appliances, and mercury found in switches and temperature control devices.

III. Emissions Inventory

Emission inventories commonly estimate the total current emissions and the total banked emissions – emissions from current products that will occur in the future. Appliances are manufactured in controlled factory environments that minimize emissions during production, and emissions in use are broadly prevented by the encapsulation of refrigerants and foam blowing agents in the appliance.[10] Current emissions from appliances are heavily focused at EOL. The banked emissions are an important focus as they are the potential future emissions that can be mitigated through appliance EOL management.

Estimates of the magnitudes of high-GWP GHG emissions from refrigerants and foam banks in California appliances were estimated based on two sources. First, an inventory-based estimate was developed using the US EPA's estimates of the total refrigerators and freezers in the U.S. and data specific to the amount of high-GWP GHGs used in appliances. Second, an estimate was obtained from the US EPA's Vintaging Model.[11]

The Vintaging Model provides estimates of high-GWP GHG from foams collectively from all applications (i.e., domestic refrigeration, mobile air conditioning, large commercial chillers, etc.), but estimates are not provided for each application. As the Vintaging Model does not provide detail information for foam from domestic appliances, data for GHGs from foams is provided from the inventory based estimate only.

Estimating the magnitudes of high-GWP GHGs from refrigerants and foam banks in California appliances based on two data sources results in a range of potential banks as follows:

Table II – Potential Magnitude of High-GWP GHG Banks ($MMTCO_2E$)			
	Non Kyoto Gases ODS	Kyoto Gases HFC	Total High-GWP GHG
Domestic Refrigeration (Refrigerant)	12 to 27	2.8 to 3.3	15 to 30
Domestic Refrigeration (Foam)	27	0.0	27
Total Available in Refrigerators ($MMTCO_2E$)	39 to 54	2.8 to 3.3	42 to 57

[10] United Nations Environmental Program, Montreal Protocol on Substances that Deplete the Ozone Layer, Report of the Technology and Economic Assessment Panel: Report of the Task Force on Foam End-of-Life Issues, May 2005, page 37.

[11] *The US EPA provided data using the Vintaging Model, which estimates banks and emissions of ODS and high-GWP GHGs. California banks and emissions are estimated based on the US EPA national estimates multiplied by the percentage of the U.S. population residing in California (12.13%). The Vintaging Model is the best currently available estimator of high-GWP GHG emissions in the country.*

IV. Availability and Technological Feasibility:

Currently, at least three appliance recycling facilities operate in California recovering varying degrees of GHGs from refrigerants and foam insulation in appliances using automated recycling and recovery programs. Refrigerants in the appliances are first extracted manually, along with other hazardous materials such as compressor oil and mercury switches.

Recovery technologies employed could range from manual removal of foam from appliances to the automated appliance recycling systems. ODS destruction technologies currently exist and are proven technologies, having been in existence since the 1990s.

V. Possible ideas for Reducing GHG Emissions:

A primary goal of this measure is to increase the current recycling of the approximately 1.2 million appliances in California[12] by 25% to recycle an additional 300,000 appliances per year through early retirement programs to reduce the large bank of inefficient appliances used in California residences and businesses.

An increase of 300,000 appliances recycled through early retirement programs will require a substantial increase in recycling above the current estimated 227,000[13] refrigerators and freezers recycled through early retirement programs annually. The goal of an additional 300,000 appliances recycled is based on an estimate of the total increase possible using the current California appliance recycling infrastructure by upgrading technology and increasing the number of operating shifts, or with limited expansion of facilities.

California Public Resources Code Section 42170 requires that solid waste facilities not accept for disposal any major appliance, such as a refrigerator or freezer, which contains enough metal to be economically feasible to salvage. Based on the economic value of metals it is assumed that all of the 1.2 million appliances disposed annually are recycled, but recycling generally only includes the removal of oils, capacitors, and switches, and the recycling of metals. The EOL management of foams to capture blowing agents is common primarily to appliances recycled through early retirement programs.

To deplete the current estimated bank of refrigerants and foam blowing agents from inefficient appliances the increased level of proper appliance recycling could be maintained from the program initiation through approximately 2021, at which point appliance recycling would reduce to a level approximately equal to the number of

[12] Appliances recycled in California are estimated based on US EPA estimates that nearly 10 million refrigerators and freezers are disposed of in the U.S. each year multiplied by the percentage of the U.S. population residing in California (12.13%).

[13] The number of appliances retired in California is estimated as follows: Based on CPUC documents, Southern California Edison (SCE) projects to retire 245,000 in the three-year 2006-2008 program term. SCE serves 35.9% of California's residents (13 million / 36.25 million). Assuming all Californians were served by this program an estimated 682,000 appliances would be retired over the 2006–2008 three-year period (245,000 / 35.9%). Annually, 227,000 appliances would be retired (682,000 / 3 years).

refrigerators/freezers sold each year. At this point the goal would be to ensure that all appliances at EOL are properly recycled.

Although several tools can be used to achieve the above objectives, the primary approach considered is to support the US EPA and utility companies' appliance early retirement programs. A residential refrigeration measure work group will be established to discuss and recommend methods and potential programs to support current appliance early retirement programs, but some potential tools may include the following:

1. Partner with the US EPA and/or utility companies to provide direct assistance through ARB's existing outreach efforts to promote early retirement programs focused on proper recycling of operating, inefficient appliances.
2. Reduce emissions by recovering all available waste foam from non-operating appliances prior to landfilling, and destroying the high-GWP GHGs within the foam. This option will be discussed in the Foam Recovery/Destruction early action measure.
3. Evaluate opportunities for recognizing ODS destruction as part of the broader program that the ARB develops. For example, the US EPA helped develop an ODS destruction protocol to enable generation of credits through the Chicago Climate Exchange (CCX).
4. Develop mechanisms to increase incentives provided to consumers, businesses, and/or appliance recyclers.

VI. Emission Reduction Potential

Potential emission reductions are preliminary and best estimates using currently available data. This analysis will be further refined in 2009 from additional research to be completed by Caleb Management Services through the research study "Developing a California Inventory for Ozone Depleting Substances and Hydrofluorocarbon Banks and Emissions from Foams – RFP 07-312" (approved at the February 2008 Board Meeting).

GHG emission reductions are estimated to range depending on estimated refrigerators and freezers to be recycled in a specific year. These estimates are based on an estimated inventory of all refrigerators and freezers in California and historical data on refrigerants and foam blowing agents used.

From a 2011 program initiation through 2012 when recycled appliances are primarily pre-1996 with some pre-2002 appliances, GHG emission reductions are estimated to be up to 0.6 million metric tons of CO_2 equivalent ($MMTCO_2E$) each year for a total of 1.2 $MMTCO_2E$ for the two-year period. Of the 1.2 $MMTCO_2E$, 0.1 $MMTCO_2E$ is from Kyoto gases; 1.1 $MMTCO_2E$ is from non-Kyoto GHGs. During this time a high percentage of refrigerators and freezers disposed are expected to have used CFC-12 and CFC-11, which are very high-GWP GHGs.

From 2013 through 2015 after all pre-1996 appliances are assumed to be recycled, GHG emission reductions are estimated to be over 0.4 $MMTCO_2E$ each year for a total

of 1.3 $MMTCO_2E$ for the three-year period. Of the 1.3 $MMTCO_2E$, 0.2 $MMTCO_2E$ is from Kyoto gases; 1.2 $MMTCO_2E$ is from non-Kyoto GHGs.

From 2016 through 2020 GHG emission reductions are estimated to be nearly 0.2 MMTCO2E each year for a total of 0.8 $MMTCO_2E$ for the four-year period. Of the 0.8 $MMTCO_2E$, 0.6 $MMTCO_2E$ is from Kyoto gases; 0.2 $MMTCO_2E$ is from non-Kyoto GHGs. During this time refrigerators and freezers disposed are expected to be those from the transition period, as appliances using ODS will have already been disposed, which is why the benefits of the program begin to decline.

In 2020, the potential one-year GHG emission reductions total of 0.1 $MMTCO_2E$ are primarily all Kyoto gases.

The emission reductions above are for direct emission reductions of refrigerants and foam blowing agents. The measure is anticipated to result in energy savings of up to 210 GWh per year, which will also result in indirect emission reductions.

Measuring indirect emissions through energy efficiency can vary greatly as there are many factors to consider. Based on discussions with California Energy Commission staff, an average of 880 pounds CO_2 per MWh energy savings is a good conversion for a broad estimate of indirect emission reductions. Based on this conversion indirect emission are estimated as up to 0.1 $MMTCO_2E$

The CPUC has selected a team led by Energy and Environmental Economics, Inc. (E3) to model the electricity sector's reduction in GHG emissions.[14] As the E3 model results become available the estimate of indirect GHG emission reductions will be further refined.

VII. Cost Information:

Costs and cost savings data are preliminary and best estimates using currently available data. More detailed cost estimates of potential emission reduction programs will be provided in 2009 through the research study "Lifecycle Analysis of High-Global Warming Potential Greenhouse Gas Destruction – RFP 07-330", to be considered for approval March 2008 by the Research Screening Committee.

The costs and benefits to consumers and utility companies discussed below are based on current programs. The actual costs and benefits of any partnerships or new programs will depend on the programs developed. As energy efficiency programs can result in a net benefit to both consumers and utility companies, it is anticipated that the Air Resources Board's contribution can result in greater use of current programs resulting in an increased net benefit for consumers and utility companies.

Consumer Cost and Cost Savings:

The EnergyStar and other appliance early retirement programs supported by this measure fiscally benefit consumers. The U.S. Department of Energy estimates the

[14] CPUC GHG Modeling, http://www.ethree.com/cpuc_ghg_model.html, retrieved April 20, 2008.

average increase in a refrigerator/freezer price as a result of an EnergyStar rating is $39 to $85.[15] Although an EnergyStar rating adds to the price of a basic refrigerator or freezer, replacing an inefficient, 20-year old refrigerator with an EnergyStar rated refrigerator will save a household roughly 700 KWh/year or more - or upwards of $50/year. If a secondary refrigerator (e.g., in a basement or garage) is removed and not replaced, households can save about 1,200 KWh/year, or over $100/year.[16]

Assuming an additional 300,000 refrigerators/freezers are recycled and replaced with EnergyStar appliances as a result of the Residential Refrigerator program, at an average additional cost of $62 per appliance, total consumer capital costs would be nearly $19 million per year, but these costs may be offset by current rebate programs as well as reduced utility expenses through energy savings.

California utility companies provide rebates to encourage California residents to recycle operating, inefficient appliances to remove them from the power grid. Several additionally provide a rebate from the purchase of an EnergyStar appliance. The appliance recycling rebates from investor-owned utilities range from $35 to $50. The EnergyStar appliance purchasing rebates for investor-owned utilities range from $0 to $50. To estimate an average California total potential rebate (recycling rebate + EnergyStar purchase rebate) the total potential rebate for each utility is multiplied by the percent of total customers served by the utility, resulting in a weighting factor for each utility based on the number of customers served. Summing the weighting factors for each utility provides a weighted statewide total potential rebate of $81. So, with a potential 300,000 appliances recycled and replaced with an EnergyStar appliance resulting in an average $81 in total rebates, the total potential consumer financial benefit would be over $24 million.

With total consumer capital costs estimated at $19 million and total consumer financial benefit estimated at $24 million, the estimated net consumer benefit of recycling and replacing 300,000 appliances with EnergyStar appliances would be over $5 million.

Additional savings are derived from indirect benefits resulting from energy savings. Based on the US EPA estimate of $50 per year savings for the life of an appliance, the total consumer indirect savings would total $1,000. To extrapolate these savings over the 20-year life span of 300,000 appliances, the total indirect savings would be estimated at $300 million ($15 million per year for 20 years).

Utility Industry Cost and Cost Savings:

The cost of utility efficiency programs has averaged two to three cents per KWh saved. This is less than half of the cost of the avoided baseload generation – the generation type most often displaced by energy efficiency programs.[17] Using an estimated cost of $0.03 per KWh hour saved, the total utility industry cost to operate an appliance early

[15] U.S. Department of Energy, Technical Report: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005, page 4-16.
[16] US EPA, Appliance Disposal Practices in the United States, http://www.epa.gov/Ozone/partnerships/rad/raddisposal_factsheet.html, retrieved on February 28, 2008.
[17] Krebs, M, Testimony to United States Senate Committee on Commerce, Science, and Transportation, June 21, 2007.

retirement program was estimated by multiplying the $0.03 per KWh saved with the up to 210 million KWh saved through the proper recycling and replacement of 300,000 appliances to total $6 million in additional utility industry costs. This estimate defines a lower bound range of potential utility industry costs.

Based on annual reports submitted to the CPUC by Southern California Edison and San Diego Gas and Electric, the two utilities in 2006 recycled over 74 thousand appliances (refrigerators and freezers) with a total budget of $11.8 million,[18] or $159 per appliance. A total of 300,000 appliances at a cost of $159 per unit provides an upper bound range of over $47 million in utility costs.

Utility companies benefit through avoided cost to create generating capacity. California utility energy efficiency programs in the 2006-2008 three-year program term are expected to have a return on investment of 200%. Thus, using the lower bound estimate of utility industry costs, the utility industry benefit resulting from the proper recycling of 300,000 appliances is estimated as total cost multiplied by 200%. The total benefit is estimated at $12 million – 200% of the $6 million costs.

Based on the lower bound estimate of utility industry costs of $6 million and utility industry cost avoidance benefit estimated at $12 million, the estimated net utility industry resource benefit of recycling and replacing 300,000 appliances with EnergyStar appliances would be approximately $6 million.

Depending on the process used to estimate costs, utility companies' costs for appliance recycling programs vary greatly. The costs and benefits of the Residential Refrigeration program will be discussed and further refined in ongoing discussions with stakeholders.

Appliance Recycling Cost:

The consumer and utility industry cost estimates do not take into account capital outlays to build new recovery, processing, or destruction facilities. The current estimate of appliances recycled through early retirement programs is 227,000 annually at three facilities. If we assume all plants operate 300 days per year with two shifts, the average productivity of all plants is estimated at recycling 16 appliances per hour. Expansion to include an additional 300,000 appliances could be achieved by 1) increasing production at all plants to 37 appliances per hour, 2) increasing production at all plants to 24 appliances per hour and adding a third shift at all plants, or 3) increasing production to 27 appliances per hour and adding one additional plant.

Although many appliances are recycled through early retirement programs, there remains a large percentage not recycled through these programs. If all of the anticipated 1.5 million appliances to be recycled annually after 2011 were to be recycled at facilities similar to current facilities, then there would be a need for expansion to

[18] Energy Efficiency Programs and Program Reports, http://www.cpuc.ca.gov/PUC/energy/electric/Energy+Efficiency/Programs/, retrieved April 22, 2008.

increase production to 35 appliances per hour, increase all plants to three shifts, and to add an additional three facilities.

VIII. Outstanding Questions/Barriers/Issues

The estimates for annual emissions and banks of foam previously described are the best available estimates as of January 2008. These estimates are based on national figures, scaled down to California's percentage of the national population, and may not reflect conditions specific to California.

Research is being conducted to refine the estimation of total banks of high-GWP GHGs from insulation foam used in appliances, buildings, commercial refrigeration units, transport refrigerated units, and other miscellaneous sources in California. Final results are anticipated by the end of 2009.

The major outstanding issues with respect to this strategy involve how to encourage increased appliance recycling by consumers and increased involvement in the RAD program, or other appliance early retirement programs, by non-participating utilities, local transfer stations, landfills, and salvage yards (to the degree that they receive unwanted working appliances).[19]

As there are current programs specific to the early retirement of residential refrigerators an additional outstanding question is how a new strategy should be developed to ensure not to compete with, but to add value to current programs.

<u>Questions regarding voluntary appliance recycling option:</u>

- What are the economic incentives (if any) of a voluntary program?
- Should incentives be increased to expand focus from energy savings benefit to also include a GHG emission reductions benefit?
- Would any economic assistance be available to assist with a voluntary program?
- How can new program concepts be designed to ensure a synergistic benefit to add value to current programs?

IX. Other Environmental Benefits of Potential Strategies

By recovering and destroying ODS from old appliances, the strategy addresses both climate change as well as stratospheric ozone depletion.

X. Key Stakeholders

The following entities are expected to be affected by the mitigation strategies being considered:

- Alliance for Responsible Atmospheric Policy (ARAP)
- Appliance Recycling Centers of America (ARCA)
- Association of Home Appliance Manufacturers (AHAM)

[19] It is anticipated that the mandatory foam recovery strategy will result in both working and non-working appliance fees to increase at landfills, transfer stations, and salvage yards to ensure that they are sent to best-practice recycling facilities for complete high-GWP GHG recovery and/or destruction.

- California Department of Toxic Substance Control (DTSC)
- California Energy Commission (CEC)
- California Integrated Waste Management Board (CIWMB)
- California-based electrical utility companies
- Institute of Scrap Recycling Industries (ISRI)
- JACO Environmental
- US EPA

XI. Related Studies Underway

Costs and cost savings data are preliminary and best estimates using currently available data. More detailed cost estimates of potential emission reduction programs will be provided in 2009 through the research study "Lifecycle Analysis of High-Global Warming Potential Greenhouse Gas Destruction – RFP 07-330", to be considered for approval March 2008 by the Research Screening Committee.

Research is being conducted to refine the estimation of total banks of high-GWP GHGs in California. The research is being completed by Caleb Management Services through the research study "Developing a California Inventory for Ozone Depleting Substances and Hydrofluorocarbon Banks and Emissions from Foams – RFP 07-312" (approved at the February 2008 Board Meeting).

XII. Citations

The following references were utilized in addition to those already cited within the body of the document:

American Chemical Society (2001, June 28). Refrigerator Disposal Releases Ozone-Depleting Chemicals. ScienceDaily. Retrieved February 1, 2008.

Department of Energy, Carbon Dioxide Emissions from the Generation of Electric Power in the United States, DOE, 7/2000: http://tonto.eia.doe.gov/FTPROOT/environment/co2emiss00.pdf, retrieved February 28, 2008.

Department of Energy, Carbon Dioxide Emissions from the Generation of Electric Power in the United States, DOE, 7/2000: http://tonto.eia.doe.gov/FTPROOT/environment/co2emiss00.pdf, retrieved February 28, 2008.

Godwin, Peterson, and VanPelt, Modeling Emissions of High Global Warming Potential Gases, 12th International Emission Inventory Conference, April 30, 2003.

Intergovernmental Panel on Climate Change/Technology and Economic Assessment Panel, IPCC Special Report on Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons, May 19, 2005.

IPCC/TEAP, IPCC Special Report on Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons, 2005.

Montreal Protocol: The 20th Anniversary of the Montreal Protocol – A Landmark Environmental Treaty, http://www.epa.gov/ozone/downloads/MP20_Backgrounder.pdf, retrieved February 1, 2008.

Ozone Layer Depletion - Alternatives / SNAP, http://www.epa.gov/ozone/snap/index.html, retrieved February 1, 2008.

Scottish Environmental Protection Agency, Guidance on the Recovery and Disposal of Controlled Substances Contained in Refrigerators and Freezers, 2002: http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge_consultation.pdf, retrieved February 28, 2008.

US EPA, Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.

US EPA, Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.

US EPA, U.S. High GWP Emissions 1990-2010: Inventories, Projections and Opportunities for Reductions, EPA 000-F-97-000, June 2001.

US EPA, U.S. High GWP Emissions 1990-2010: Inventories, Projections and Opportunities for Reductions, EPA 000-F-97-000, June 2001.